KC-1
FHP

United States
Department of
Agriculture

Forest Service

**Pacific
Northwest
Region**

Forest Disease Management Notes

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

This packet was prepared for

_____

- ☐ Animal Damage
- ☐ Annosus Root and Butt Rot
- ☐ Armillaria Root Rot
- ☐ Atropellis Canker
- ☐ Black Stain Root Disease
- ☐ Brown Crumbly Rot
- ☐ Brown Cubical Butt Rot
- ☐ Brown Felt Blight
- ☐ Brown Trunk Rot
- ☐ Cedar Leaf Blight
- ☐ Comandra Blister Rust
- ☐ Cytospora Canker
- ☐ Damping-off
- ☐ Dark Brown Cubical Rot
- ☐ Douglas-fir Dwarf Mistletoe
- ☐ Elytroderma Needle Blight
- ☐ Fir Broom Rust
- ☐ Fusarium Root Rot
- ☐ Gray Mold
- ☐ Gray Saprot
- ☐ Hemlock Dwarf Mistletoe
- ☐ Incense Cedar Rust
- ☐ Laminated Root Rot
- ☐ Larch Dwarf Mistletoe
- ☐ Larch Needle Blight
- ☐ Lodgepole Pine Dwarf Mistletoe
- ☐ Lophodermella Needle Casts
- ☐ Mechanical Injury
- ☐ Mottled Rot
- ☐ Needle Cast of Larch
- ☐ Pecky Rot
- ☐ Phomopsis Canker of Douglas-fir
- ☐ Phytophthora Root Rots of Seedlings
- ☐ Port-Orford-Cedar Root Rot
- ☐ Red Band Needle Blight
- ☐ Red Ring Rot
- ☐ Rhabdocline Needle Cast
- ☐ Rhizina Root Rot
- ☐ Rust Red Stringy Rot
- ☐ Spruce Broom Rust
- ☐ Spruce Cone Rust
- ☐ Stalactiform Rust
- ☐ Swiss Needle Cast
- ☐ True Fir Dwarf Mistletoe
- ☐ True Mistletoes
- ☐ Western Dwarf Mistletoe
- ☐ Western Gall Rust
- ☐ White Mottled Rot
- ☐ White Pine Blister Rust
- ☐ White Pocket Root and Butt Rot
- ☐ White Trunk Rot of Aspen
- ☐ Yellow Brown Top Rot
- ☐
- ☐
- ☐
- ☐

Copies of all Forest Disease Management Notes can be obtained from: Forest Pest Management, P.O. Box 3623, Portland, OR 97208. Telephone: (503) 326-2727 or FTS 8-423-2727.

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Animal Damage

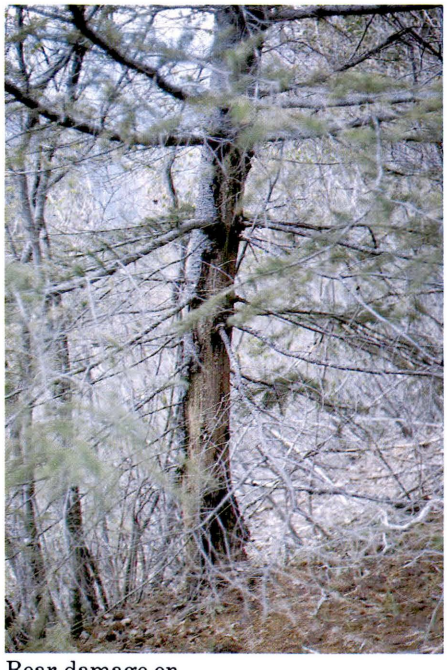
Several higher animal species cause damage to trees. The most important include porcupines, bears, mountain beavers, pocket gophers, wood rats, sapsuckers, and deer. Animal feeding creates injuries that can result in tree death or infection by wood decay fungi.

Hosts: All trees.

Symptoms: Trunk scars with teeth or claw marks; clipped tops or branches on seedlings or saplings; holes in tree (woodpeckers and sapsuckers); pocket gopher burrows present in area.

Management: Retardents or protective structures can be placed on or over seedlings to discourage deer and rodents; poisonous baits can be used against pocket gophers; snares and hunting have been used against bears.

May be Confused With: Root diseases, comandra rust.



Bear damage on
young Douglas-fir

Sapsucker damage

Porcupine damage on
ponderosa pine

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Annosus Root and Butt Rot

Annosus root and butt rot is caused by the fungus, *Fomes annosus*. Estimates of loss are not available for the Pacific Northwest. The disease causes growth loss, root and butt rot, uprooting, and tree killing. Damage is increasing in pine and true fir stands.

Hosts: All conifers, especially common in western hemlock and white fir. Damage is seldom seen except in pines, hemlock, and true firs.

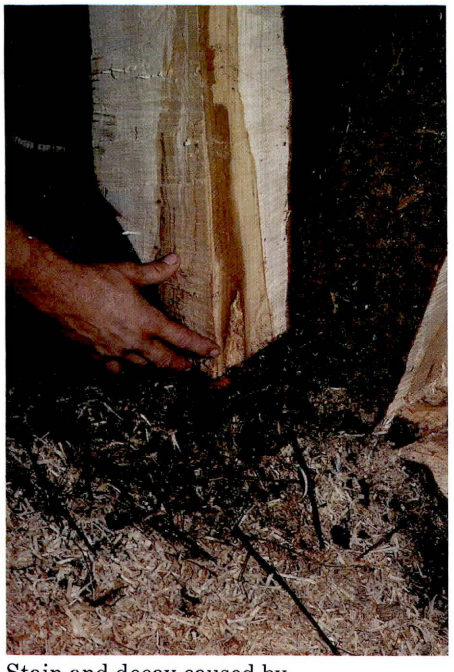
Recognition: Resinous hosts, especially pines, exhibit decreased terminal growth, needle yellowing, pitch soaking of root wood, decline, and death; nonresinous hosts exhibit stain or a white stringy rot in roots and butts; windthrow may occur. Rot often has small black specks.

Perennial, flat, button, or bracket-shaped leathery conks in hollows, crotches, or on root collars of dead trees or stumps, often below the duff surface; conks are brown to tan with a lighter colored sterile margin and white pore surface.

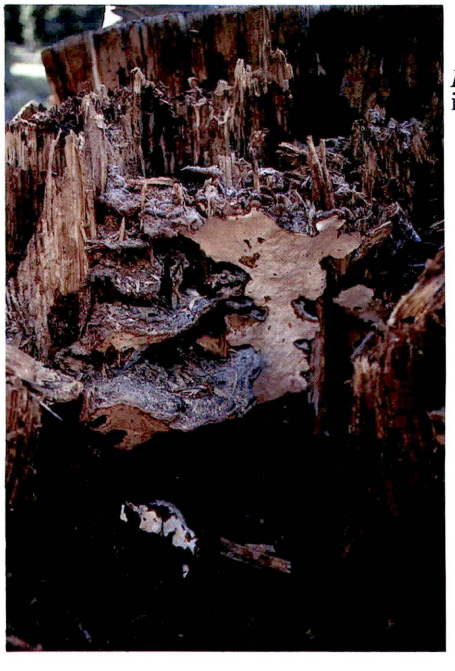
Disease Spread: Windborne spores germinate on freshly cut stump surfaces; the fungus colonizes the stump and roots; roots of surrounding live trees that are in contact with those of the stump become infected as well; infection also may occur through wounds on live trees; tree to tree spread continues across root grafts and contacts; secondary attack by bark beetles is common.

Management: Careful logging practices aimed at minimizing injury to residual trees; removal of severely wounded trees during stand improvement activities. Short rotations (40-120 years) in western hemlock and true firs will minimize decay loss. Trees with decay associated with wounds or with root or butt rot should be treated in recreation areas. When stain or decay is not present, treat fresh stumps with borax to prevent infection in recreation areas. Infected stumps could be removed in high value sites.

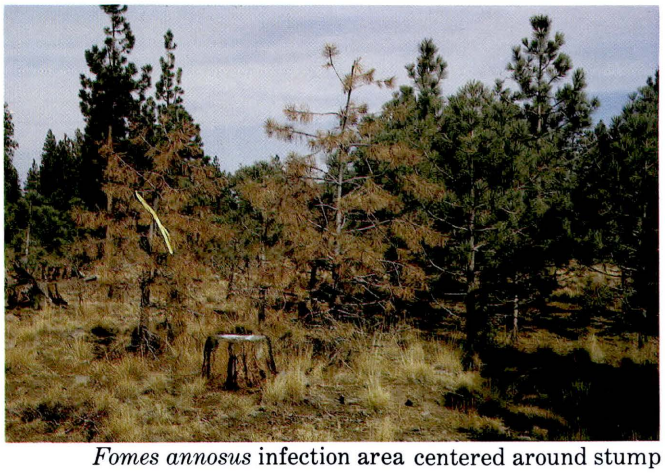
May be Confused With: Laminated root rot, Armillaria root rot.



Stain and decay caused by *Fomes annosus* in western hemlock



Fomes annosus conks in white fir stump



Fomes annosus infection area centered around stump

Typical *Fomes annosus* conks on western hemlock

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Armillaria Root Rot

Armillaria root rot, also called shoestring root rot, is caused by the fungus *Armillaria mellea*. This is the most common conifer root rot in the Pacific Northwest. Infection results in growth loss, root and butt rot, uprooting, and tree killing.

Hosts: Virtually all trees and other woody species.

Recognition: Decline in growth increment, foliage yellowing, distress cone crop, heavy resin flow at tree base, tree death; early decay appears as a watersoaked area with tiny pockets; advanced decay is a yellow stringy rot; butt rot sometimes develops in non-resinous hosts, especially hardwoods. Disease centers contain numerous stubs, snags, and dying trees.

White mycelial sheets often shaped like fans develop under bark of roots and lower bole; rhizomorphs (black or brown shoestring-like structures) form in the same areas; mushrooms are golden-yellow with a ring on the stem and grow from infected material in the fall.

Disease Spread: The fungus survives and grows in old stumps or dead trees; rhizomorphs are formed and grow through the soil to infect the roots of new hosts; spread also occurs across root contacts and grafts; spread by spores is negligible. On the West Side Douglas-fir develops resistance to the disease at age 20-30. Disease centers usually occur around infected stumps of the former overstory. Secondary attack by bark beetles is common. Frequently occurs on trees affected by other root diseases.

Management: West Side - Maintain vigorous growing stock. In severely diseased areas, plant or favor species that appear only lightly or not affected; remove stumps of infected trees to sanitize severely infected sites. Do not thin severely infected areas. **East Side** - Precommercial thinning or harvesting and stump removal may be necessary to sanitize severely infected sites. Normal tree harvesting does not reduce or prevent infection and may aggrevate the problem. Infected trees should be treated in recreation areas.

May be Confused With: No other disease or insect if mycelial fans are present.

Diagnostic mycelial fan
under bark of
Armillaria mellea-infected tree

Basal resin flow
associated with
Armillaria mellea infection

Armillaria mellea mushrooms

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Atropellis Canker

Atropellis canker of pines is caused by two fungi, *Atropellis piniphila.* and *A. pinicola.* The disease occurs in many lodgepole pine stands, but only a relatively few are severely infected. Infection can result in reduction of wood quality, stem breakage, and occasionally tree killing. Bark is difficult to remove from cankers.

Hosts: Especially damaging on lodgepole pine; also affects western white, ponderosa, and sugar pines.

Recognition: Elongated, flattened depressions, covered with roughened bark on stems and branches; heavy resin flow; dead branches; misshapened stems; occasional mortality of small trees.

Small black or dark brown fruit bodies (apothecia and conidial stromata) form on dead bark in the cankers; dark, bluish stain in the wood behind cankers (the fungus invades the ray cells and the stain is wedge-shaped in cross section).

Disease Spread: Windborne spores infect new hosts throughout the growing season; spores are not released until fruiting bodies are moistened; cankers may continue to produce spores several years aften tree death; most infection occurs through unbroken bark in the nodal region, though some infection occurs through branch stubs; open-grown trees are less subject to infection than trees in overstocked stands.

Management: Remove infected trees during thinning; thin heavily stocked stands early to make conditions less favorable for the disease; clearcut heavily-infected stands in wide strips or large blocks and destroy small unmerchantable trees in the clearcuts; encourage development of mixed species stands; plant non-susceptible tree species in areas where infection has been severe; after cutting unmerchantable infected trees, it may be desirable to burn or chip them as cankers may continue to produce inoculum for several years after host death. Trees with deeply indented stem cankers should be treated in recreation areas.

May be Confused With: Stalactiform rust on lodgepole, white pine blister rust on western white and sugar pines.

Atropellis canker on lodgepole pine

Stain under Atropellis canker

Fruit bodies of *Atropellis piniphila*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Black Stain Root Disease

Black stain root disease is caused by the fungus *Ceratocystis (Verticicladiella) wageneri.* Incidence of this disease is increasing in the Pacific Northwest, particularly in Douglas-fir plantations. Infection results in growth loss and tree killing.

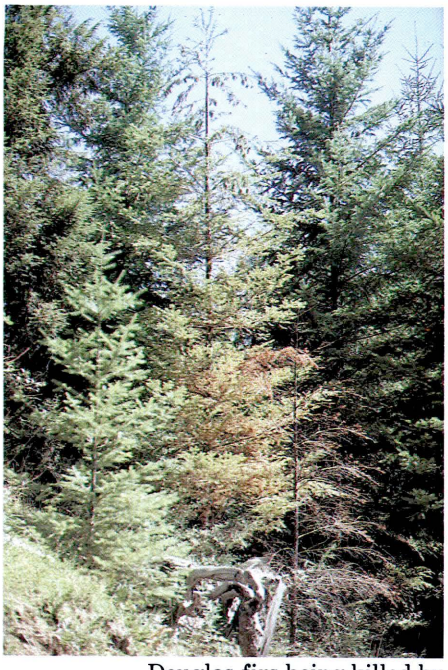
Hosts: Major hosts are Douglas-fir and ponderosa pine; mountain hemlock, western hemlock, lodgepole pine, sugar pine, and western white pine are infected occasionally.

Recognition: Dark-brown to purple-black stain in the sapwood of roots, root crowns, and lower stems are especially diagnostic. Growth reduction, foliage yellowing, distress cone crops, basal resinosis, rapid decline, death; symptoms may begin on one side of the tree.

Disease Spread: Occurs in stands with a large component of host species; in the Pacific Northwest, most common in 10-30 year-old Douglas-fir plantations; sometimes found killing ponderosa pine on moist East Side sites; usually found causing discrete infection centers which contain old dead trees and trees in all stages of disease development; spreads from tree to tree across root contacts and grafts at a rate of 6-12 feet per year; long distance spread probably involves bark beetle and weevil vectors; the fungus dies soon after death of the host tree.

Management: Remove host trees in infection center and 50-foot buffer strip; replant with non-hosts. Host trees may be planted 1 year after infected trees are removed.

May be Confused With: Laminated root rot, Armillaria root rot, mountain pine beetle damage or animal feeding on roots.



Douglas-firs being killed by black stain root disease

Diagnostic stain caused by *Ceratocystis wageneri* in Douglas-fir

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Brown Crumbly Rot

Brown crumbly rot is caused by *Fomitopsis (Fomes) pinicola*, commonly called the redbelt fungus. This is the most commonly observed rotter of slash and dead trees in the Pacific Northwest. Conks are occasionally seen on dead portions of living conifers and indicate considerable decay.

Hosts: Practically all conifers.

Recognition: Hard, woody, perennial, shelf- to hoof-shaped conks (2-10 inches width); smooth, gray to black upper surface with a wide red margin; undersurface is white to yellowish. Brown cubical rot of sapwood and heartwood.

Disease Spread: Spores released from conks are carried by wind. They germinate on exposed wood. Insects spread the fungus by carrying mycelial fragments when they emerge from decayed trees.

Management: Avoid wounding of living trees; salvage living trees with conks. Trees with conks should be treated in recreation areas.

May be Confused With: White mottled rot *(G. applanatum)*, red ring rot *(F. pini)*, and red-brown butt rot *(P. schweinitzii)*.

Conks of *F. pinicola*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Brown Cubical Butt Rot

Brown cubical butt rot is caused by *Phaeolus (Polyporus) schweinitzii*, often called the velvet-top fungus. This fungus causes extensive butt rot in infected trees. It is common in old-growth trees, particularly those with fire scars. It can also cause a tree-killing root rot in young trees.

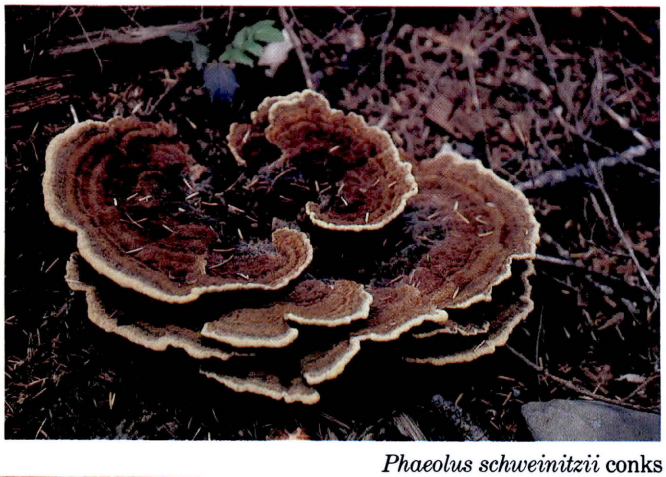
Hosts: Douglas-fir, pines, spruces, larch.

Recognition: Large mushrooms may occur on ground near or growing from the base of infected trees and on the stem rarely over 10 foot above the ground; these appear in late summer and fall and are at first red-brown with a yellow, velvet tinge; as they age, they attain a dark brown color and resemble cow droppings; mushrooms growing on the ground have a circular shape with a depressed center and taper to a short, thick stalk; those growing on trees are often bracket-shaped; thin crust-like mycelial layers frequently are found in shrinkage cracks of decayed wood. There may be no evidence of early decay, or it may show as a yellow to reddish-brown discoloration running a few inches to several feet ahead of advanced decay; advanced decay is a distinctive dry, crumbly, brown cubical rot; decay is limited to heartwood and normally is confined to roots and butt of the host; extreme decay frequently results in breakage or windthrow.

Disease Spread: Windborne spores infect new hosts through fire scars and wounded roots; also spreads along roots; mostly a problem on older trees, though young trees occasionally are affected. The fungus can persist in roots of dead or cut trees and infect roots of the developing trees.

Management: Avoid wounding trees; when possible, harvest trees before they become overmature; in recreation areas, treat all trees showing evidence of infection by this fungus.

May be Confused With: Brown trunk rot *(F. laricis)*, brown crumbly rot *(F. pinicola)*, white pocket root rot *(I. tomentosus)*.



Phaeolus schweinitzii conks

Characteristic brown cubical rot caused by *Phaeolus schweinitzii*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Brown Felt Blight

Brown felt blight is caused by two similar fungi, *Herpotrichia nigra* and *Neopeckia coulteri*. Although this disease is common in some years, it causes almost no economic loss in forests.

Hosts: *H. nigra* - conifers other than pines; *N. coulteri* - pine species.

Recognition: Common at high elevations; lower branches are covered with dense cobwebby growths of brown to black mycelium that kill foliage; small black globular fruit bodies are scattered over the mycelium; the two fungi are macroscopically identical.

Disease Spread: Fungi develop on foliage under snow; high humidity and mild temperatures (Optima are 50° F for *N. coulteri* and 59-64° F for *H. nigra*), are required for fungus growth; brown mycelium is very resistant to adverse conditions; after snowmelt, fruit bodies form on mycelium and release spores that are windborne and infect susceptible foliage; damage is primarily growth loss.

Management: Usually none is warranted except in nurseries or on ornamentals; foliage sprays of 5% Zineb or Maneb applied before first snowfall are effective in control.

May be Confused With: Gray mold (seedlings).

H. nigra on white fir

N. coulteri on lodgepole pine

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Brown Trunk Rot

Brown trunk rot is caused by *Fomitopsis officinalis* commonly called the quinine conk. Decay by this fungus is most common in old-growth trees. Trees bearing quinine conks usually are extensively decayed.

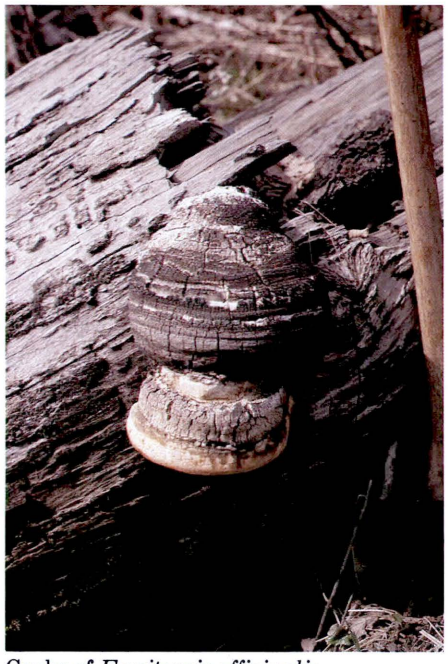
Hosts: Douglas-fir, larch, pines.

Recognition: Conks can be large (4-8 x 8-24 inches), dirty white throughout, chalky, and pendulous or hoof-shaped; mycelial felts are abundant in shrinkage cracks of decayed wood (felts taste bitter); brown cubical rot of heartwood.

Disease Spread: Infections occur through broken tops, branch stubs, or other wounds, especially in old-growth trees; spores are windborne.

Management: None warranted except avoidance of stem wounding. Conks generally indicate complete cull. Salvage merchantable trees with dead tops to prevent cull. Trees with conks should be treated in recreation areas.

May be Confused With: Brown cubical butt rot (*P. schweinitzii*), brown crumbly rot (*F. pinicola*).



Conks of *Fomitopsis officinalis*

Decay and mycelial felts in shrinkage cracks

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Cedar Leaf Blight

Cedar leaf blight caused by the fungus, *Didymascella (Keithia) thujina* appears sporadically in the Pacific Northwest. Damage is rarely serious in forest stands.

Hosts: Western redcedar, mainly a problem of seedlings and young saplings.

Recognition: Foliage, especially of lower branches in dense stands, takes on a scorched appearance; in the spring leaves turn reddish-brown then gray; in fall, infected leaf twigs drop, leaving the branches bare. In the spring following infection, circular to elliptical olive-brown to black fruit bodies are formed in the upper surfaces of infected leaves.

Disease Spread: Spores are discharged from June to mid-October during periods of moist weather and infect new foliage; trees in the interior of dense stands or in deep ravines where the air is stagnant and moist are most likely to be infected; seedlings covered by snow are also prone to severe infection.

Management: Several applications of fungicide throughout summer and fall will control the disease in nurseries; no control yet devised for forest stands and is rarely required.

May be Confused With: Normal fall foliage drop.

Cedar leaf blight

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Comandra Blister Rust

Comandra blister rust caused by the fungus, *Cronartium comandrae* is an important disease only in local areas of the ponderosa pine type in the Pacific Northwest. It kills branches, tops, and entire trees.

Hosts: Primary hosts- hard pines, most serious on ponderosa pines; alternate host- bastard toadflax (Comandra).

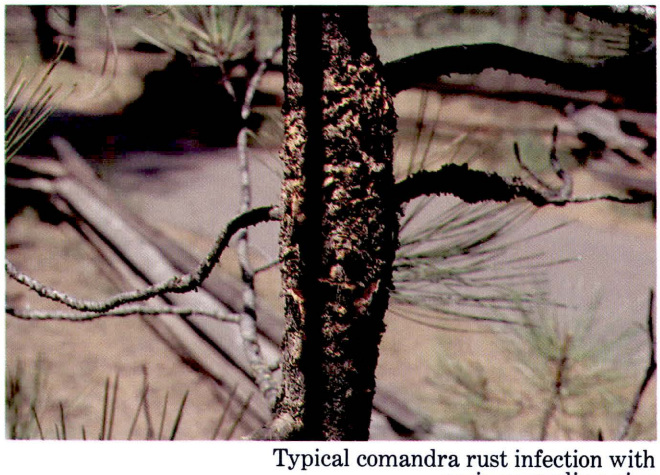
Recognition: Spindle-shaped, often inconspicuous swellings are formed on pine stems and branches; infections break open and produce a cracked and pitted canker or lesion with abundant resin flow; rodents frequently gnaw bark from infections; "flags" (dead branches with discolored foliage attached) and dead tops are common; the fungus grows slowly down infected stems causing progressive dying; tree mortality may occur, especially in young trees.

On pines, inconspicuous reddish-orange ooze or drops (pycnia) appear on swellings in the summer 1 to 3 years after infection; dark orange spore pustules (aecia) rupture through bark in the spring of the following year. On bastard toadflax leaves yellow spots with yellow spore pustules (uredia) and brownish hair-like structures (telia) occur throughout the summer and fall.

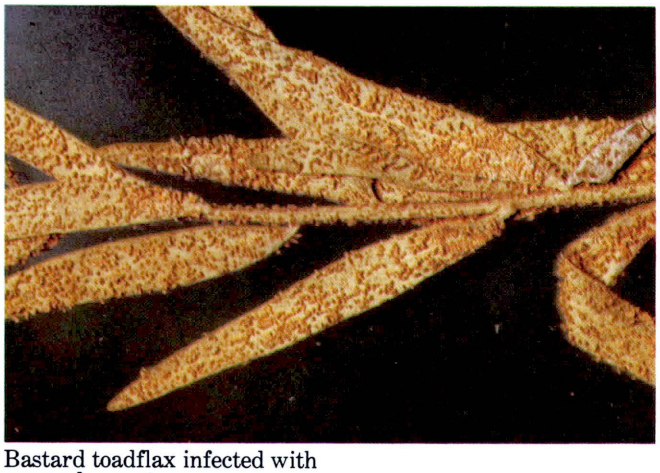
Disease Spread: Beginning in late spring, aeciospores are released from pine hosts and are carried by wind to infect bastard toadflax; aeciospore production continues until fall but tapers off as the season progresses; uredia and telia are produced within a few weeks to a month on bastard toadflax leaves; urediospores reinfect bastard toadflax causing intensification of the disease; pines are infected by windborne spores in the late summer or fall; comandra rust is favored by cool, moist conditions at the time of infection of both hosts; pine infection tends to occur in wave years when weather conditions are especially favorable (wet summers).

Management: Concentrate on removing infected trees during thinning and stand improvement operations; log severely infected stands; replace susceptible pines with less susceptible species in area where plantations have failed due to heavy infection. Control of bastard toadflax is impractical.

May be Confused With: Insect attack, animal damage, dwarf mistletoe, environmental damage.



Typical comandra rust infection with aecia on sapling pine



Bastard toadflax infected with comandra rust

Dead top caused by comandra rust

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Cytospora Canker

Cytospora cankers are caused by several species of fungi in the genus *Cytospora*. This disease is usually associated with environmental stress. It occurs sporadically in the Pacific Northwest, but with the exception of the dwarf mistletoe - Cytospora association, it seldom causes serious damage.

Hosts: Weakened conifers; *Cytospora abietis* frequently is found on dwarf mistletoe-infected true firs, and an unidentified *Cytospora* has been found causing stem cankers on sapling and polesize Douglas-fir.

Recognition: Slightly sunken, gradually enlarging cankers on branches or stems, heavy resin flow on canker face, death of branches; occasionally, death of trees.

Small pimple-like fruit pustules (pycnidia) on dead bark; large numbers of spores ooze from these fruit bodies in mild wet weather, forming yellow-orange tendrils.

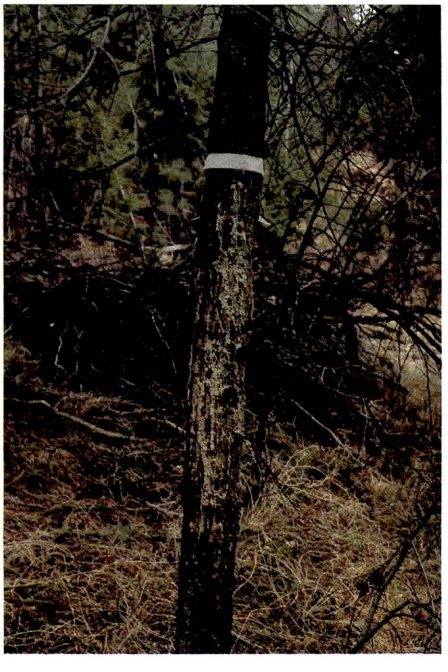
Disease Spread: Spores are carried by wind, insects, and birds, or rain splash; new hosts are infected through wounds or dead twigs; the fungus only affects weakened trees, trees on poor sites, injured trees, and especially drought-weakened trees; *Cytospora abietis* on true firs commonly infects dwarf mistletoe-infected branches; *Cytospora* species are most successful when bark is relatively thin; predisposes trees to bark beetle attack and possibly root diseases.

Management: Maintain a vigorous stand; control dwarf mistletoe; avoid wounding trees; use local seed source stock; remove trees with severe flagging and low live-crown ratios.

May be Confused With: Fir broom rust, animal damage, environmental damage.

Branch canker associated with *Cytospora abietis* and dwarf mistletoe on Pacific silver fir

Cytospora canker on Douglas-fir



Cytospora spore tendrils

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Damping-off

Damping-off of seedlings is caused by fungi in the genera *Phytophthora, Pythium, Fusarium,* and *Rhizoctonia.* Damage can be extensive in wet springs or poorly drained soils. Damping-off results in death of succulent seedlings and root rot with associated stunting in older seedlings.

Hosts: Conifer seedlings.

Recognition: Pre-emergent damping-off is characterized by failure of seedlings to emerge due to the infection and decay of the young radicals. Post-emergent damping-off is characterized by infection and decay of succulent stem tissue at or just below the ground line causing seedlings to fall over. At the point of infection, the stem is watersoaked and necrotic. Root infections of slightly older seedlings may also occur causing partial or total decay; in these cases seedlings may remain upright after dying.

No visible signs of fungi are seen on damped-off seedlings. Fungi are easily cultured from infected seedlings and can be separated from one another by differences in spore and mycelium characteristics.

Disease Spread: Damping-off fungi are soil inhabitants, surviving either as dormant spores or mycelium in organic matter. After the seedlings are infected, additional mycelium or spores are formed within seedling tissue so that the population of damping-off fungi increases with each successive crop of trees. Generally, high moisture and high soil pH favor damping-off. Infection by damping-off fungi is usually most severe in very young, succulent seedlings, but these fungi may attack roots of older woody seedlings as well. The disease can be spread by movement of infested soil and seedlings.

Management: Nursery beds with high damping-off fungi populations should be fumigated prior to sowing. Avoid excessive movement of soil between fumigated and nonfumigated areas. Provide good drainage. Maintain acid soil (pH 5.5). Seed treatments have not proven to be consistently effective in preventing damping-off losses. Soil drenches with registered fungicides may be effective if applied soon after sowing.

May be Confused With: Heat injury, wind injury, non-germinating seeds.

Damped-off
Douglas-fir seedling

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Dark Brown Cubical Rot

Dark brown cubical rot is caused by the fungus *Laetiporus (Polyporus) sulfereus.* It is commonly called the "sulphur fungus."

Hosts: Hemlocks, spruces, pines, larches, true firs, hardwoods.

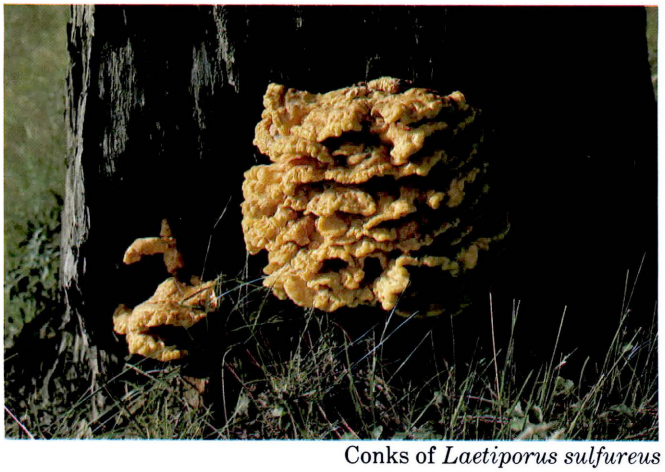
Recognition: Brown cubical rot of the heartwood.

Soft, watery, shelving, annual conks are produced in overlapping clusters; upper surface is bright orange to yellow; lower surface is sulfur yellow; mycelial sheets abundant in shrinkage cracks of decayed wood.

Disease Spread: Infections by spores occur through dead branch stubs and wounds; often a butt rot in conifers but less localized in hardwoods; conks usually indicate complete cull; generally a minor problem in living conifers.

Management: Avoid stem wounds; remove live trees with broken tops, sizable wounds, or fruit bodies; harvest old, decadent trees. Trees with fruit bodies should be treated in recreation areas.

May be Confused With: Nothing if conks are present; brown crumbly rot and red brown butt rot if conks are absent.



Conks of *Laetiporus sulfureus*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Douglas-fir Dwarf Mistletoe

Douglas-fir dwarf mistletoe, *Arceuthobium douglasii*, is probably the most damaging disease of Douglas-fir in eastern Washington and eastern and southern Oregon. It infests 42% of the Douglas-fir type on the East Side. Infection causes growth loss, wood quality reduction, top-killing, and tree killing.

Host: Douglas-fir.

Recognition: Leafless, olive-green shoots (about ¼ to ½ in. long) on infected branches in witches'-brooms; branch and stem swellings, witches'-brooms that can reach massive sizes, dead tops, and dead trees.

Disease Spread: Seeds are sticky and forcibly shot from fruits in the fall; most seeds travel less than 10 feet; seeds germinate in spring, infection occurs on thin bark wood. Disease spread is most rapid in multi-storied stands; spread in single-storied stands averages 1-2 feet per year.

Death of host results in death of dwarf mistletoe. Infections are systemic (spread internally) in Douglas-fir.

Management: Clearcut severely infested stands; remove infested overstory if a managable susceptible understory is present. Remove severely infected trees in lightly infested stands; favor non-hosts in mixed stands.

May be Confused With: Brooms caused by viruses or genetic abnormalities.

Douglas-fir stand severely infested with dwarf mistletoe

Dwarf mistletoe plants on Douglas-fir

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Elytroderma Needle Blight

Elytroderma needle blight of ponderosa pine is caused by the fungus *Elytroderma deformans*. It is the most important foliage disease of ponderosa pine in the Pacific Northwest. Infection occurs at low levels in many stands, but usually only becomes damaging at elevations around 3,500 feet in Washington and 5,000 feet in Oregon. Trees in high infection zones suffer from growth loss, attack by bark beetles, and tree killing.

Hosts: Ponderosa pine, Jeffrey pine, and rarely, lodgepole pine.

Recognition: "Flags" (reddened, dead 1-year-old needles with green current season needles at tip) are conspicuous in spring; small to large compact witches'-brooms with upward turning branches and many dead needles occur when infections become perennial; inner bark of infected branches contains numerous dark dead lesions; if severely infected, entire tree tops may be misshappened, growth loss occurs, and occasionally, trees die or are predisposed to bark beetles and root diseases.

Clear tendrils of inconspicuous pycnidiospores appear on reddened needles in spring; black, elongated fruit bodies (hysterothecia) form on dead needles in summer.

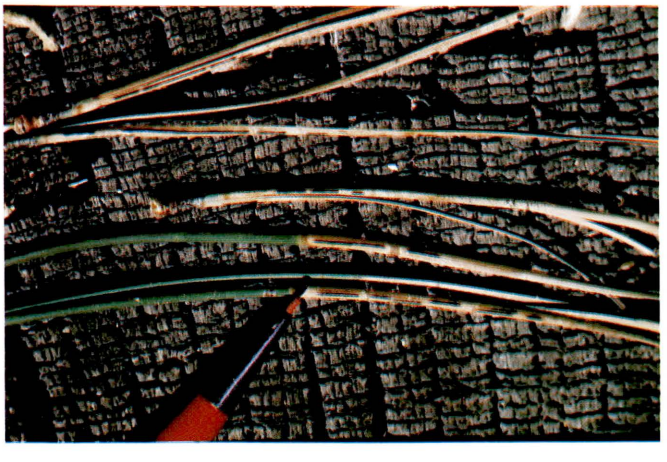
Disease Spread: Windborne spores are released from hysterothecia for several months beginning in July; only current year's foliage is infected; high humidity and cool temperatures favor infection; and the disease is most severe in microsites where these conditions prevail. The fungus grows from needles into woody tissues. Infections in woody tissues remain active for many years, reinfecting needles and producing spores that begin new outbreaks when environmental conditions are especially favorable for the fungus.

Management: In immature stands - (1) maintain good spacing but avoid creating large openings in the stand, (2) remove as many severely infected trees as possible when thinning (no trees with "flags" within 6 feet of the leader should be retained), (3) prune infected branches where economically justifiable; **in mature stands** - (1) recognize that considerable infection can occur without causing appreciable damage; avoid hasty action, (2) evaluate the situation annually, watch for evidence of serious damage (tree death, bark beetle attacks, etc.), (3) log stands when damage becomes severe - discriminate against moderately to heavily infected trees in the residual stand.

May be Confused With: Dwarf mistletoe, Dothistroma needle blight, Lophodermella needle cast.

"Flagging" caused by *Elytroderma deformans*

Witches'-broom caused by *Elytroderma deformans*



Hysterothecia of *Elytroderma deformans*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Fir Broom Rust

Fir broom rust, caused by the fungus *Melampsorella caryophyllacearum*, is occasionally seen in Pacific Northwest true fir stands. Damage is seldom extensive enough to be serious.

Hosts: Primary hosts- true firs; alternate hosts- chickweed.

Recognition: Causes formation of conspicuous dense, upright witches'-brooms on true firs; needles on broom twigs are extremely yellow and shorter and thicker than healthy needles; broom foliage dies in the fall, causing the broom to appear dead in the winter; can be confused with dwarf mistletoe brooms, but contains no dwarf mistletoe plants; severe infection may result in stem malformation, growth loss, and occasionally, mortality; causes a leaf or shoot blight of chickweed.

Yellow spore pustules (aecia) appear in great numbers on needles of witches'-brooms in summer; orange spore pustules (uredia and telia) occur on chlorotic chickweek leaves in spring and summer.

Disease Spread: Both fir and chickweed hosts are required for completion of the life cycle; windborne basidiospores infect newly opened fir buds in spring; the mycelium becomes perennial in the fir host, causing production of a witches'-broom; aeciospores are produced the following summer (and each summer thereafter), are windborne and infect chickweed; infection on chickweed also may be perennial and is intensified by urediospore infection; infection is favored by moist conditions.

Management: Remove trees with main stem infections when practical; other control measures are not considered economically feasible and are seldom warranted.

May be Confused With: Dwarf mistletoe.

Witches'-broom in true fir caused by *Melampsorella caryophyllacearum*

Needles bearing aecia of *Melampsorella caryophyllacearum*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Fusarium Root Rot

Fusarium root rot of conifer seedlings caused by the fungus *Fusarium oxysporum* f. sp. *pini* is the most serious disease in Pacific Northwest bareroot nurseries. Damage in the form of seedling death and stunting can become very serious if sites are not treated.

Hosts: Conifer seedlings.

Recognition: In newly emerging seedlings, causes "damping off" (collapse of the seedling at ground line); in older seedlings, causes typical root rot symptoms: rootlet deterioration, foliage yellowing, general decline, and death; bark of infected seedlings sloughs off easily; mortality generally scattered randomly throughout nursery beds.

A variable colored mycelial growth can sometimes be seen on roots and at the base of the stem; diagnostic microscopic canoe-shaped (macroconidia) and smaller round spores (microconidia) form readily in culture.

Disease Spread: The fungus survives in soil on organic matter or as resting spores (chlamydospores) and infects succulent, young roots; warm, moist conditions favor the fungus; especially damaging to very young seedlings (seldom serious in seedlings 2 years old or older). Soil and seedling movement in nurseries can spread the disease.

Management: Fumigate nursery soils with methyl bromide-chloropicrin; maintain good soil drainage in nurseries.

May be Confused With: *Pythium, Phytophthora.*

Nursery bed experiencing scattered Fusarium root rot mortality

Seedlings killed by Fusarium root rot

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Gray Mold

Gray mold of seedlings is caused by the fungus *Botrytis cinerea.* This disease is especially common in container nurseries and in dense 2-year-old and older beds in bareroot nurseries. Cool, wet conditions favor the fungus.

Hosts: All tree species, especially Douglas-fir.

Recognition: Brownish-gray mold (fungus mycelium) on infected portions of plants; microscopic fruit bodies that release puffs of spores when infected seedlings are agitated. Yellowing and browning of foliage of stored seedlings; top dieback, bark sloughing, girdling, root deterioration; seedling death, frequently involving groups of closely associated seedlings.

Disease Spread: *Botrytis cinerea* is a common saprophyte and soil inhabitant. Infection and disease spread are favored by high seedling densities, dead vegetation, and cool, moist conditions in the field and greenhouse. Spores are spread by wind currents, agitation, or water. In storage, warm temperatures, stagnant air, and moist conditions favor the spread of infection throughout boxes or bundles of stored trees. Wounding predisposes trees to infection; fully dormant seedlings are less susceptible than those that have not yet hardened off.

Management: Avoid conditions favorable for the pathogen; apply fungicides when the disease is noticed or anticipated. Keep storage areas clean and cool (preferrably between 28° and 36°F), well ventilated, and as dry as possible without dessicating seedlings (avoid standing water); if molds do develop, remove infected material from storage areas and consider fungicide application such as Bravo or Botran.

May be Confused With: Other molds, environmental damage, brown felt blight.

Botrytis cincerea-infected seedling on right, healthy seedling on left

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Gray Saprot

Gray saprot is caused by the fungus *Cryptoporus (Polyporus) volvatus*, often called the pouch fungus. The fungus is very common on recently killed conifers.

Hosts: Occurs on most conifers, but most common on ponderosa and lodgepole pine.

Recognition: Superficial soft grayish saprot of slash and dead trees.

White to tan leathery globose annual conks issue from insect holes in the bark; brown tube layer is completely enclosed by a leathery membrane.

Disease Spread: Conks appear 6-18 months after tree death; bark beetles carry mycelial fragments of the fungus from infected to uninfected trees; tunneling activities of the beetles create suitable infection courts for fungus establishment; spores are probably not insect disseminated and are relatively unimportant in the infection process.

Management: Generally not a problem on living trees. Salvage dead trees promptly. Conky trees in recreation areas should be removed.

May be Confused With: Nothing if conks are present.

C. volvatus conk on Douglas-fir

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Hemlock Dwarf Mistletoe

Hemlock dwarf mistletoe, *Arceuthobium tsugense*, infests 21% of the western and mountain hemlock types in the Pacific Northwest. Severe infestations cause growth loss, wood quality reduction, and tree killing. Damage is much more serious in stands over 100 years old than in younger stands.

Hosts: Principal- western and mountain hemlock; Secondary- Pacific silver, subalpine, and noble fir, coastal lodgepole, western white, and white-bark pine.

Recognition: Leafless, green or red dwarf mistletoe shoots (about 2 in. long) appear on infected branches; basal cups of old detached shoots remain on branches. Branch and stem swellings, witches'-brooms, dead tops, branch flagging; branch mortality is accentuated by fungi that invade mistletoe infections; severely infected true firs are predisposed to attack and mortality by fir engravers (*Scolytus ventralis*).

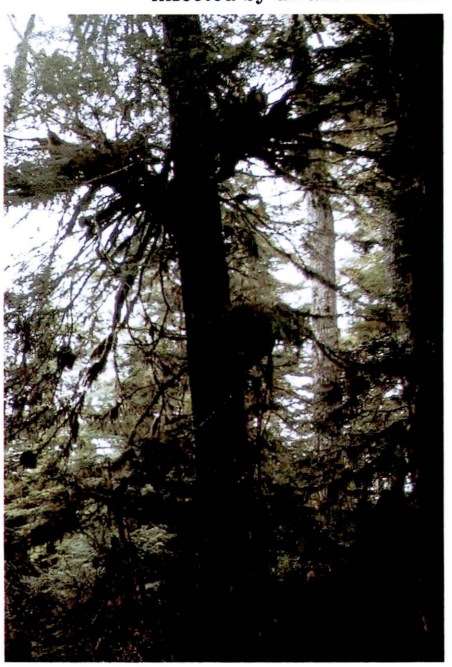
Disease Spread: Seeds are sticky and forcibly shot as far as 50 feet from fruits in the fall; seeds germinate in the spring, infection occurs on thin bark wood; spread is most rapid in multi-storied stands; spread in single-storied stands averages 1-2 feet per year; spread is faster in open than dense stands; death of host results in death of dwarf mistletoe.

Management: Clearcut severely infested stands, remove infested overstory if a manageable susceptible understory is present; remove severely infected trees in lightly infested stands; destroy infected live residuals left after clearcutting, fires, or blowdown; favor non-hosts in mixed stands; trees with open-faced stem cankers or with dead tops should be treated in recreation areas; prune witches'-brooms in recreation sites to prolong tree life.

May be Confused With: True fir dwarf mistletoe on ture firs, but the effects are the same. Suppressed western hemlocks form simulation brooms when they are released. Simulation brooms do not have dwarf mistletoe shoots.

Hemlock dwarf mistletoe plants

Western hemlock severely infected by dwarf mistletoe



Flagging in noble fir caused by hemlock dwarf mistletoe and canker fungi

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Incense Cedar Rust

Incense cedar rust is caused by the fungus *Gymnosporangium libocedri.* Incidence of the disease is sporadic in southern Oregon. Damage is seldom serious.

Hosts: Incense cedar; alternate hosts- serviceberry, hawthorn, apple, pear, quince, and mountain ash.

Recognition: Red-orange, gelatinous spore pustules (telia) appear on infected incense cedar foliage in spring. On incense cedar, causes spindle-shaped branch and trunk swellings with numerous small dark-brown flecks often in a fan- or wedge-shaped pattern in wood, witches'-brooms and death of small sprays of foliage; heavy infection results in crown deformation; small black fruiting bodies on the alternate host produce an orange colored liquid (pycnial exudate) in early summer; later, whitish-yellow spore cups (aecia) are produced in clumps usually on the undersurfaces of infected leaves; on alternate hosts causes light-yellow, circular spots on leaves, fruits, and tender green shoots.

Disease Spread: Teliospores germinate in place, producing basidiospores that are windborne and infect alternate hosts in spring; aeciospores released during the summer are also windborne, and infect incense cedar leaves or young stems; high humidity favors infections on both hosts; symptoms appear on cedars 1 year after infection; mycelium of the fungus survives in cedar tissues for many years.

Management: Prune infected branches of ornamental or nursery trees; no control is warranted in the forest.

May be Confused With: True mistletoe.

Witches'-broom on incense cedar caused by *Gymnosporangium libocedri*

Telia of *Gymnosporangium libocedri* on cedar foliage

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Laminated Root Rot

Laminated root rot, caused by the fungus *Phellinus (Poria) weirii* is responsible for an annual estimated volume loss of 32 million cubic feet in the West Side Douglas-fir type. Surveys indicate approximately 5% of the area of highly susceptible host types in Oregon and Washington is out of production because of this disease. It causes growth loss, butt decay, uprooting, and tree mortality.

Hosts: Highly susceptible- Douglas-fir, mountain hemlock, Pacific silver, white, and grand fir; intermediately susceptible- spruces, larch, western hemlock, red, noble, and subalpine fir; tolerant- lodgepole, sugar, and western white pine; resistant- ponderosa pine, western red and incense cedar; immune- hardwoods.

Recognition: Growth increment reduction, especially height, foliage yellowing, distress cone crop, slow crown decline, death; infected trees are often windthrown, exhibiting a "root ball" where roots have rotted off just below the root crown; early decay appears as a reddish stain, usually crescent shaped or semi-circular in cross-section; advanced decay is a laminated rot, the wood separating readily at the growth rings and containing numerous small, elliptical pits; butt rot is more common than tree killing in tolerant species.

White to grayish mycelium on bark surface of roots (ectotrophic mycelium); reddish, whiskery mycelium between layers of rotted wood; flat gray to brown fruit bodies formed in protected locations but infrequently observed.

Disease Spread: The fungus can survive for decades in large old stumps or roots; new hosts are infected when their roots contact old infected material; tree to tree spread occurs across root grafts and contacts; infection centers are generally small (less than 1 acre) and scattered on West Side, large on East Side; trees of all ages are affected; secondary attack by bark beetles is common.

Management: Remove infected trees from infection centers and susceptible hosts from a 50-75 foot buffer strip then (1) replant with resistant conifers or immune hardwoods or (2) remove stumps and roots and replant with susceptible species. Trees with signs or symptoms should be treated in recreational areas. Favoring less susceptible tree species is usually the most practical treatment.

May be Confused With: Annosus root and butt rot, brown cubical butt rot, black stain root disease, Armillaria root rot, or animal feeding on roots.

"Root ball" characteristic of *Phellinus weirii* infection

Ectotrophic mycelium of *Phellinus weirii*

Typical laminated *Phellinus weirii* rot

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Larch Dwarf Mistletoe

Larch dwarf mistletoe, *Arceuthobium laricis* is present in 47% of the western larch type in the Pacific Northwest. Infected trees suffer growth loss, wood quality reduction, and death.

Hosts: Principal- western larch; Secondary- subalpine larch, subalpine fir, mountain hemlock, lodgepole pine. Occasional- Engelmann spruce, whitebark, and ponderosa pine.

Recognition: Leafless, dark-purple dwarf mistletoe shoots (1.5-4 in. long) on infected branches. Stem and branch swellings, witches'-brooms, "spike-top" trees. Stem burls occur where infected branches break off.

Disease Spread: Seeds are sticky and forcibly discharged from fruits in the fall; seeds germinate in spring, infection occurs through thin bark on stems and branches. Spread is most rapid in multi-storied stands; infections cause branch or stem swelling and eventual death of member; death of host results in death of parasite.

Management: Clearcut severly infested stands, remove infested overstory if a manageable susceptible understory is present; remove severly infected trees in lightly infested stands; favor non-hosts in mixed stands; in recreation areas, trees with large, dead tops should be treated.

May be Confused With: No other disease resembles larch dwarf mistletoe.

Larch dwarf mistletoe plants

Larch dying from dwarf mistletoe

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Larch Needle Blight

Larch needle blight is caused by the fungus *Hypodermella laricis*. This disease appears frequently throughout Pacific Northwest larch stands. Trees in forest stands generally do not experience serious damage even though the disease may appear to be spectacular.

Hosts: Western larch.

Recognition: Needles are reddish-brown over their entire length as if scorched by fire; damage generally occurs in June; typically, all needles on a spur are affected.

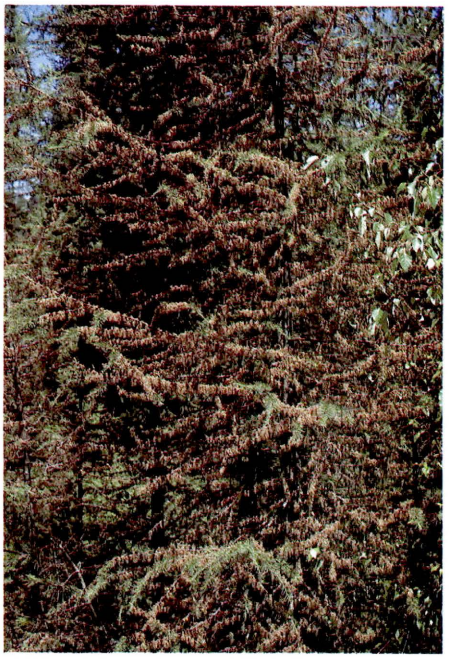
Small, black fruit bodies (hysterothecia) are formed on dead needles; fruit bodies often merge to form narrow rows.

Disease Spread: Airborne spores infect larch needles in early spring, immediately after budbreak; mature needles are immune; 6 weeks after infection, needles turn red and die; later in summer, hysterothecia form on dead needles; infected needles are retained for 1 year or more; spores develop in hysterothecia in autumn; following spring rains, hysterothecia rupture and release spores; spores on the old needles can also be carried by rain splash to newly emerging foliage to cause infection; infected crowns generally refoliate the following season; repeated infection may cause growth loss and, rarely, mortality.

Management: None warranted in forest stands; in nurseries or on ornamentals, benomyl or maneb applied repeatedly during infection period (1 week before to 2-3 weeks after budbreak) should prevent disease.

May be Confused With: *Meria laricis*, larch casebearer.

H. laricis hysterothecia on western larch



Larch needles killed by H. laricis

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Lodgepole Pine Dwarf Mistletoe

Lodgepole pine dwarf mistletoe, *Arceuthobium americanum*, infests 42% of the lodgepole pine type in the Pacific Northwest. Severe infestations cause growth loss, wood quality reduction, and tree killing. Dwarf mistletoe is the most serious disease affecting lodgepole pine.

Hosts: Lodgepole pine.

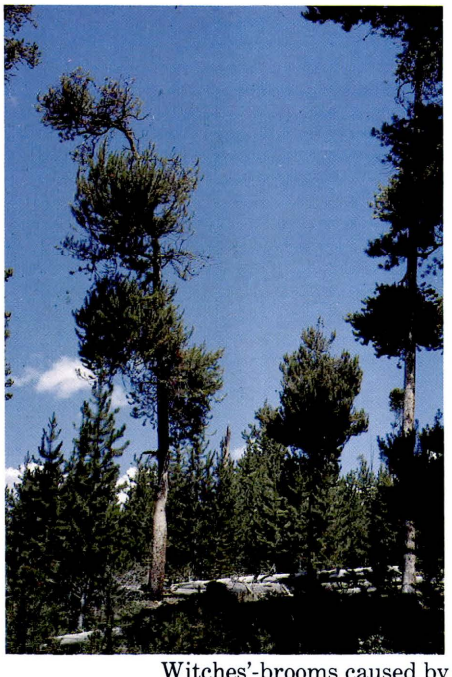
Recognition: Leafless, yellow to olive-green dwarf mistletoe shoots (about 2.5 in. long) appear on infected branches and stems; basal cups of old, detached shoots remain on branches; branch and stem swellings, witches'-brooms, branch and top death.

Disease Spread: Dwarf mistletoe seeds are sticky and forcibly discharged from fruit for distances up to 50 feet in the fall; seeds germinate in the spring, infection occurs on thin bark wood; spread is most rapid in multi-storied stands; spread in single-storied stands averages 1-2 feet per year; spread is faster in open than dense stands; dwarf mistletoe is a true parasite, dying with host death.

Management: Clearcut severly infested stands, remove the infested overstory if a manageable susceptible understory is present; remove severely infected trees in lightly infested stands; favor non-hosts in mixed stands; maintain even-aged stands in single species forests; prune witches'-brooms in recreation sites to prolong tree life.

May be Confused With: Simulation brooms produced when suppressed trees are released. Simulation brooms do not have dwarf mistletoe shoots.

A. americanum plants on lodgepole pine



Witches'-brooms caused by dwarf mistletoe

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Lophodermella Needle Casts

Several species of fungi in the genus *Lophodermella* cause needle casting of Pacific Northwest pines. Appearance of the disease is sporadic and strongly influenced by weather conditions. Trees are seldom killed directly by Lophodermella needle casts.

Hosts: Pines.

Recognition: Affected needles turn brown in spring of year following infection; trees take on a scorched appearance; needles are cast; if infected for several years, trees have a "lion tailed" appearance and are weak and unthrifty.

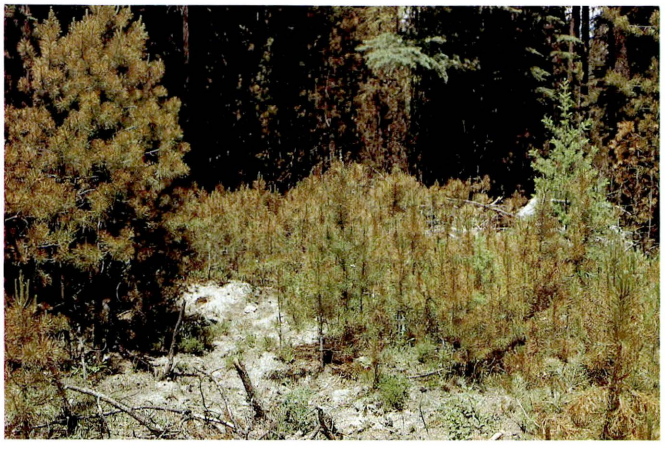
Short, elliptical fruit bodies are produced (hysterothecia) on the needles after they die.

Disease Spread: New host needles are infected by windborne and rain-splashed spores in early summer; only succulent, young needles are infected; symptoms appear the following year; infection is greatly favored by moist conditions; disease is most serious on young or small trees.

Management: Usually none warranted. Avoid planting offsite pine stock, especially in damp areas (canyons, basins, fog belts, etc.). Nursery or ornamental trees may be protected by spraying with two applications of bordeaux mixture, once when new needles are half-grown and again when growth ceases.

May be Confused With: Dothistroma needle blight, environmental damage, Elytroderma needle blight, root diseases.

Ponderosa pines infected by *Lophodermella morbida*



Lodgepole pines infected by *Lophodermella concolor*

Dead ponderosa pine needle bearing hysterothecia of *Lophodermella morbida*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Mechanical Injury

Mechanical injuries are caused by a large number of agents. The most common are wind, hail, falling trees, and man-operated equipment. Large losses are associated with mechanical injury. Injuries commonly become infected by wood decay fungi.

Hosts: All trees; thin barked species are more subject to wounding.

Recognition: Windthrown and broken trees lying approximately in the same direction indicate damage from severe wind; hail damage appears mostly on thin bark stems, twigs, and occurs only on the upper sides; scars from equipment (bulldozers, axes, etc.) resemble animal feeding wounds, but lack teeth marks; wood is often goughed.

Management: None for hail; for wind, avoid opening up shallow rooted stands, especially in root-diseased areas; equipment-caused damage can be reduced by good pre-sale preparation and proper logging techniques.

Pre-Sale Preparation

1. Do not log in spring or early summer in easily injured species.
2. Select equipment appropriate to site.
3. Mark leave trees rather than those to be cut.
4. Lay out skid trails in advance.
5. Cut short logs.
6. Do not thin stands of young, thin-barked species too heavily.

Logging Techniques

1. Harvest trees first in skid trails.
2. Cut stumps low to prevent skidder shunting.
3. Fell trees either away or toward skid trails.
4. Use end-line skidding.
5. Limb, top, and buck logs before skidding.

May be Confused With: Insect and animal damage.

Damage caused by severe winds

Hail injury on grand fir

Scarring caused by logging equipment

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Mottled Rot

Mottled rot is caused by the fungus *Pholiota limonella.* This is often called the "yellow cap fungus."

Hosts: Hardwoods, hemlock, true fir.

Recognition: Brown mottled rot of heartwood.

Soft annual mushrooms with yellow central stem appear on infected trees in late summer and fall; upper surface is sticky, slightly scaly and yellow; undersurface has yellow to brown gills; mushrooms may appear in clusters.

Disease Spread: Generally associated with wounds, especially basal scars on old growth. The fungus produces spores that are carried by winds. They can cause infection if they land on wood exposed by wounds.

Management: Avoid tree wounding; remove live trees with sizable wounds or mushrooms; harvest old, decadent trees. Trees with basal scars or mushrooms should be treated in recreation areas.

May be Confused With: Armillaria root rot.

Mushrooms of *P. limonella*

Decay associated with *P. limonella*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Needle Cast of Larch

Needle cast of larch is caused by the fungus, *Meria Laricis*. This disease appears sporadically throughout Pacific Northwest larch stands and nurseries growing larch seedlings. Trees in forest stands generally do not experience serious damage even though the disease may appear spectacular. Damage is greatest on 2-year and older seedlings in nurseries. Tree killing can occur in nurseries.

Hosts: western larch (*Larix occidentalis*), subalpine larch (*L. lilyalii*), European larch (*L. decidua*), Japanese larch (*L. leptolepis*), and hybrid larch (*L. eurolepis*).

Recognition: Needle discoloration and browning begin at the tips or in the middle of the needle, spreading from the tip downward. Not all needles on each individual spur shoot are affected. Lower portion of trees are often affected first. Infected needles are cast early. Discoloration first appears in mid- to late-spring.

Spore clusters are found in and emerging from stomatal openings on the underside of needles. Spore clusters are white and difficult to see without staining and magnification.

Disease Spread: Short distance spread occurs by spores travelling from infected to healthy needles or trees. Spores probably are spread via wind or water droplets. Long distance spread can occur by transplanting infected stock into disease-free areas. Infection and spread are favored by moist weather. The fungus overwinters in needles on the ground or in the trees.

Management: No measures are available or needed for control of needle cast in forest trees. Control in forest nurseries is achieved by:

1. Use of benomyl and maneb fungicides at 1.0 and 1.5 lbs. a.i./100 gallons of water at bud swell, 1 month after first application, and at 2 or 3 week intervals thereafter. Continue applications until weather becomes dry or until the end of July.

2. Transplant seedlings at end of first year to seedbeds where larch have not been grown recently to prevent reinfection of new growth by the fungus overwintering in fallen needles.

3. Avoid introduction of diseased stock into disease-free nurseries. This can be accomplished by growing all larch stock from seed.

May be Confused With: Frost damage, *Hypodermella laricis*, larch casebearer.

Needle discoloration caused by *Meria laricis*

Meria laricis on 2-0 seedlings

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Pecky Rot

Pecky rot, caused by the fungus *Polyporus amarus*, is the most important stem decay of incense-cedar in Oregon. Conks indicate extensive decay columns.

Hosts: Incense-cedar.

Recognition: Early rot appears as a yellowish brown discoloration in the heartwood; advanced decay consists of round-ended pockets (1/2-12 in. long) containing dark brown, crumbly, dry rot with numerous longitudinal shrinkage cracks; as decay intensifies, pockets become more numerous and sometimes nearly coalesce; rot is confined to the heartwood and usually is not prominent in the butt of the tree; shot-hole cups (depressions in the bark caused by woodpeckers searching for insects at a former conk location) are common indicators of infection.

Annual conks form on the bark above open knots in late summer or fall; conks are hoofshaped, 4 to 9 in. wide, and buff to bright yellow in color; when fresh, conks are soft and moist, becoming firm and dry with age; numerous small angular pore openings cover the underside of the conks; conks are destroyed rapidly by insects.

Disease Spread: Airborne spores infect, chiefly through open fire wounds, large open knots, and broken branch stubs; trees are particularly susceptible when growing in ravines or other locations favoring the retention of surface moisture on exposed heartwood; mainly a problem of older trees; trees exhibiting either conks or shot-hole cups are almost certain to be unmerchantable as the result of extensive decay.

Management: Lower rotation age for incense-cedar; fell trees with conks and shot-hole cups; avoid injuring trees. Trees with conks should be removed in recreation areas.

May be Confused With: Nothing.

Polyporus amarus conk

Pecky rot caused by *Polyporus amarus*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Phomopsis Canker of Douglas-Fir

Phomopsis canker of Douglas-fir is caused by the fungus *Diaporthe (Phomopsis) lokoyae.* This disease appears periodically in the Pacific Northwest, typically 1 or 2 years after droughts. Damage is usually not serious. Infection can result in cankers, top-killing, and tree killing of small trees.

Hosts: Douglas-fir.

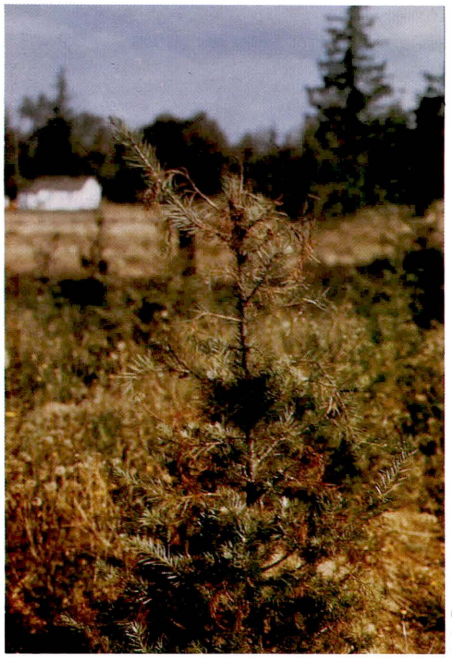
Recognition: Infection causes distinct roundish or oval sunken cankers with brown bark. Bark sloughs in the following growing season. Some resin flow may occur following infection. Small dead branchlets are frequently in the center of cankers. Bark on dead growing tips has a blackish-brown scorched appearance. Fruit bodies appear as fine black pimples on dead bark.

Disease Spread: Fungus spreads by spores produced in fruit bodies; wind-borne spores are forcibly ejected from sexual fruit bodies (perithecia); rain-disseminated spores ooze out of asexual fruiting bodies (pycnidia); spores infect small shoots and mycelium spreads to the main stem; the fungus is endemic on suppressed trees and branches and becomes locally epidemic during droughts.

Management: Avoid poor planting sites and over-crowding; in nurseries watering during dry periods will prevent weakening and predisposition to the disease; pruning off affected branches will help control the disease on ornamental trees.

May be Confused With: Sunscald, wounds, animal damage.

Phomopsis canker on young Douglas-fir



Top-kill by Phomopsis canker

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Phytophthora Root Rots of Seedlings

Several species of the fungus genus *Phytophthora* cause root rots of conifer seedlings grown in Pacific Northwest bare root nurseries.

Hosts: Conifer seedlings.

Recognition: Patches of, or scattered dying seedlings. Stunting, yellowing, and wilting usually precede death; patches may expand in size; red to brown discoloration of cambium of roots and root collar is a common symptom; the line separating discolored from unaffected tissue is usually distinct; often only root tips are infected. No visible signs of the fungi occur on the roots or above ground parts.

Disease Spread: *Phytophthoras* invade the root cambium from the soil; mycelium and infective spores of *Phytophthoras* are quite fragile and require high soil moisture to survive. Thick-walled spores (oospores, chlamydospores) are formed in host tissue. These may survive several years in the soil. Infested soil may be moved on trees, machinery, or by man to noninfested areas. Contact of spores with susceptible roots leads to spore germination and production of motile "zoospores" which infect host roots. Zoospores are spread via water or soil. More spores are formed soon after infection. Often the disease is confined to wet, low-lying areas, along drainages, or where drainage is poor. The fungus requires high soil moisture in order to infect and survive.

Management: Avoid use of low, poorly drained areas for nursery production. Improve drainage by tiling. Restrict use of machinery in infested areas, particularly when soil is wet. Prevent movement of soil from infested to noninfested areas of nursery. Avoid overwatering to puddle or run-off point. Sanitize infested beds by removing and burning all infected trees. Avoid movement of infected trees within and between nurseries. Fumigate soil before sowing. Plant resistant or less susceptible species in previously infested areas.

May be Confused With: Nematodes, Cylindrocladium root rot.

Phytophthora root rot in transplanted Douglas-fir

Cambium discoloration caused by *Phytophthora*

Wilting and killing of Douglas-fir seedlings caused by Phytophthora root rot

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Port-Orford-Cedar Root Rot

Port-Orford-cedar root rot is caused by the fungus *Phytophthora lateralis*. This is a devastating disease that has killed thousands of Port-Orford-cedars.

Hosts: Port-Orford-cedar, occasionally Alaska cedar in ornamental settings.

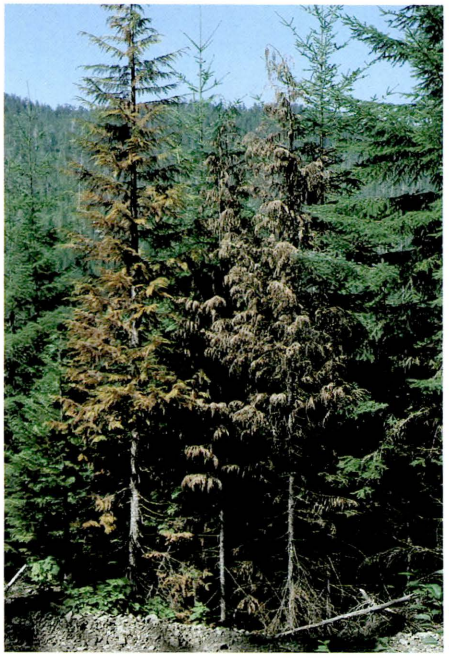
Recognition: Rapid decline and death; crowns fade from yellow through red and brown; cinnamon-brown stain in wood of roots and root crowns.

Disease Spread: Spores spread in moving water, germinating when they contact roots; spores may be carried from place to place in soil on logging equipment, animals, etc. Tree to tree spread also occurs across root grafts; conditions favorable for Port-Orford-cedar also favor the disease; *P. lateralis* is an introduced fungus, and there are only traces of resistance to the disease in Port-Orford-cedar populations.

Management: Avoid moving infested soil from infested to uninfested stands; concentrate Port-Orford-cedar on slopes that do not receive drainage from roads; favor other tree species in drainages.

May be Confused With: Armillaria root rot.

Characteristic brown stain caused by *Phytophthora lateralis*



Tree mortality caused by *Phytophthora lateralis*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Red Band Needle Blight

Red band needle blight is caused by the fungus *Dothistroma pini.* It is occasionally damaging to pines in the Pacific Northwest. Damage seems to be most severe on off-site trees.

Hosts: Most commonly infects lodgepole and ponderosa pine; other pine species are occasionally infected.

Recognition: Yellow to tan watersoaked spots and bands begin to appear on infected needles in July; these turn reddish brown with time, and the ends of the needles die; infected needles drop in late summer, fall, or, in some cases, spring of the following year; infected trees have a scorched appearance and may exhibit a "lion's tailing" effect with a few healthy needles concentrated at the outer ends of branches or near tops.

Inconspicuous (stromata) black fruit bodies containing spores form in the center of the red bands under the needle epidermis, which splits open at spore release.

Disease Spread: Spores are released from May to November, are windborne, and can infect needles of all ages; considerable moisture is necessary for germination and infection, and spores are usually released during periods of rainfall; the fungus completes its entire life cycle in 1 year; trees under 10 years old are most susceptible.

Management: None usually warranted except for nursery or ornamental trees. When necessary, control can be attained with two applications of a copper fungicide, once just before needles emerge and again shortly after; pine clones resistant to the disease can be planted in areas where the pathogen is especially damaging.

May be Confused With: Lophodermella needle casts, Elytroderma needle blight, environmental damage, root diseases.

"Lion's tailing" on a severely infected tree

Red-band symptoms on needles infected by *Dothistroma pini*

Forest Disease Management Notes

United States Department of Agriculture

Forest Service
Pacific Northwest Region

Red Ring Rot

Red ring rot, caused by the fungus *Phellinus (Fomes) pini*, is the most common stem decay of conifers in the Pacific Northwest. Enormous volumes of wood are decayed by this fungus. It is most common in old-growth stands. In addition to causing stem decay, it can form sunken cankers on true firs, especially in southern Oregon.

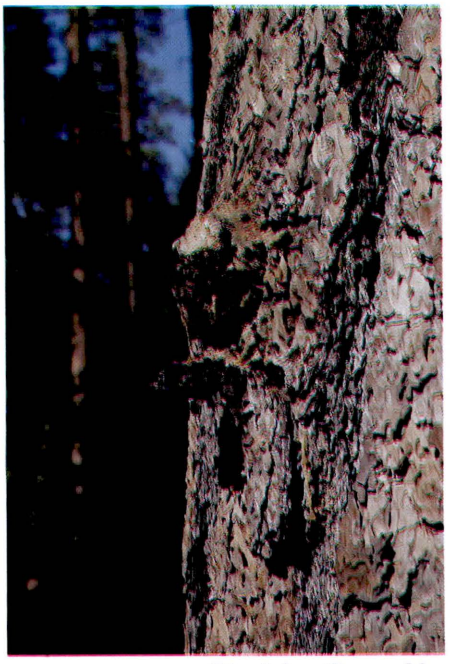
Hosts: Douglas-fir, pines, larch, hemlocks, and true firs.

Recognition: Hoof-shaped to bracket-like perennial conks on stems, often issuing from knots or branch stubs; upper surface of conk is rough, dull gray to brownish black with concentric furrows paralleling the lighter colored margin; lower surface is a rich brown color with small circular to large sinuous tube openings; context is a distinctive cinnamon color and is punky; on true firs, conks appear on sunken areas around the main stem. Early decay appears as a red to purple discoloration of the heartwood; advanced decay appears as numerous small pockets (1 mm x 2 mm) containing white mycelium (this kind of rot is commonly called "white speck") decay often occurs in concentric bands or rings; "punk knots" are an indication of infection on some trees.

Disease Spread: The disease is spread by wind-carried spores that germinate on wounds and branch stubs.

Management: Salvage infected trees before excessive merchantability is lost; increasing amounts of decay in trees are indicated by larger size and number of conks and wider spacing between them; maintain young, vigorous stands; avoid scarring trees; in recreation areas, check all trees with conks and remove those with amounts of rot sufficient to render them hazardous.

May be Confused With: Brown crumbly rot *(F. pinicola).*



"Punk knot"caused by *Phellinus pini*

Phellinus pini rot on fir

Phellinus pini var. *cancriformans* conks on white fir

Phellinus pini conks

Forest Disease Management Notes

Rhabdocline Needle Cast

Rhabdocline needle cast of Douglas-fir is caused by the fungus *Rhabdocline pseudotsugae*. This disease is occasionally common, but seldom damaging in Douglas-fir stands unless the trees are off-site.

Host: Douglas-fir.

Recognition: Yellow and purple blotches appear on infected needles in the fall and following spring. Needles drop 1 year after infection. Purplish-pink fruit bodies break through the undersides of 1-year-old needles to expose orange-brown spores.

Disease Spread: Fruit bodies mature in May to June on 1-year-old needles and spores released from them are windborne, spores require considerable moisture to germinate, because of this and since infected needles are not killed and cast until the following year, the disease is most visible following wet years; only current season's needles are susceptible. There is considerable variation in the susceptibility of Douglas-fir to this disease, in general, coastal Douglas-fir is less susceptible than the inter-mountain variety and local seed source stock is less susceptible than offsite stock, but trees within any stand show different levels of infection (many trees are immune); disease is most common on trees 5-30 years old.

Management: Usually none is warranted; disease normally causes growth loss, not mortality; nonsusceptible trees can be favored when thinning; establish plantations with local seed sources; may be controlled by fungicides or rogueing in Christmas tree plantations.

May be Confused With: Swiss needlecast, root diseases.

Browning of previous year's needles infected by *Rhabdocline pseudotsugae*

Defoliation caused by Rhabdocline needle cast

Fruit bodies of *Rhabdocline pseudotsugae* on undersurface of Douglas-fir needles

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Rhizina Root Rot

Rhizina root rot is caused by *Rhizina undulata*, sometimes called the teapot fungus. Seedlings affected by this disease usually die. It does not cause serious large-scale losses. Small groups of seedlings may be killed. Damage is most common in the northern Washington Cascades.

Hosts: Young conifer seedlings (Douglas-fir, pines, spruces, hemlocks, true fir).

Recognition: Similar to those caused by drought or other root diseases; foliage becomes yellow, seedlings decline rapidly and die.

Brown to black, fleshy fruit bodies (apothecia) resembling liver grow on duff or mineral soil around infected seedlings; when fresh, fruit bodies have a whitish-yellow margin and a yellow-gray undersurface. Fruit bodies are attached to host roots or other organic material in the soil by root-like structures called rhizoids.

Disease Spread: Infects only seedlings established on recently burned areas and is usually damaging in such areas for only 2 years after burning; wind carried spores settle in soil and are activated by high temperatures created when slash is burned; the mycelium either directly attacks seedling roots or colonizes old roots and burned wood from which it infects newly established seedlings; mortality occurs during the growing season; fungus most prevalent on moist but not wet sites. Damage is most severe in northwest Washington.

Management: In most cases, no special management is necessary because damage is negligible; in localized areas where past damage has been severe, future damage can be avoided by piling and burning slash and not planting in the burned areas, or by delaying planting for 1½ to 2 years after broadcast burning.

May be Confused With: Other root diseases, drought.

Rhizina undulata ascocarp and dead infected seedling

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Rust Red Stringy Rot

Rust red stringy rot is caused by *Echinodontium tinctorium*, commonly called the Indian paint fungus. Decay is most serious in old-growth trees. One large conk indicates approximately 40 feet of cull. This is the most important cause of stem decay of true firs in the Pacific Northwest.

Hosts: True firs, hemlocks.

Recognition: Hard, woody, hoof-shaped conks occur, mostly at branch stubs; the upper surface of the conk is dull black and rough, the undersurface is gray and composed of coarse teeth; the interior of the conk is bright orange. Early decay appears as a light-brown stain in the heartwood; advanced decay is a rust-red stringy rot; "punk knots" are sometimes found on infected trees.

Disease Spread: Windborne spores infect new hosts through tiny (0.5 mm) dead branch stubs; the fungus remains dormant until the tree is stressed (usually by wounding). Once activated, it rapidly decays wood.

Management: Maintain a vigorous stand; keep rotations to less than 150 years if possible; salvage infected trees before merchantability is lost; avoid wounding trees; monitor decay in infected trees in recreation areas and remove trees that have conks; when thinning, avoid leaving trees suppressed for more than 50 years; avoid retaining advanced regeneration that is over 50 years old, that is growing under conky old-growth, or that is growing on sites poorly adapted for hemlock or fir growth. A computer program is available to assess the risk of rust red stringy rot in suppressed understories.

May be Confused With: Nothing, especially when conks are present.

Typical rot caused by *Echinodontium tinctorium*

Echinodontium tinctorium conk

Interior of *Echinodontium tinctorium* conk

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Spruce Broom Rust

Spruce broom rust is caused by the fungus *Chrysomyxa arctostaphyli.* It is occasionally seen in Pacific Northwest spruce stands, but seldom causes damage.

Hosts: Primary hosts- spruces; alternate host -kinnikinnick.

Recognition: Causes conspicuous witches'-brooms; with profuse short twigs; needles on witches'-broom twigs are yellow in summer, die, and are shed in fall, leaving brooms to appear dead during winter; heavy infection results in spike-tops, dead branches, bole deformation, growth loss, and, occasionally, tree mortality; causes a purple-brown leaf spot on kinnikinnick.

Whitish-yellow spore pustules (aecia) occur in great numbers on foliage of witches'-brooms in summer; brooms appear yellow; orange-brown spore pustules (telia) occur on the undersides of kinnikinnick in late spring.

Disease Spread: Both hosts are required for completion of the life cycle; spores that infect both hosts are windborne, and moist conditions favor infection.

Management: Brooms could be pruned from ornamental trees; seldom serious enough in Pacific Northwest forest stands to justify control.

May be Confused With: Dwarf mistletoe, which rarely infects spruces.

Chrysomxa arctostaphyli broom on spruce

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Spruce Cone Rust

Spruce cone rust is caused by two fungi, *Chrysomyxa pirolata* and *C. monesis*. Incidence of this disease is sporadic in the Pacific Northwest. It can cause considerable damage to spruce seed crops in local areas.

Hosts: Primary hosts- spruces; alternate hosts- winter green and single delight.

Recognition: On spruce, causes malformation, browning, and premature opening of cones accompanied by destruction of seeds; yellow spore masses (aecia) develop between cone scales; on alternate host, may cause slight atrophy, yellowing of foliage, or no visible symptoms; yellow spore pustules (uredia and telia) form on leaves, petioles, stems, peduncles, and flowers of alternate host in spring, summer, and fall.

Disease Spread: Both spruce and alternate hosts are required for completion of the pathogen's life cycle, but perennial infections and continuing urediospore production make long-term survival, intensification, and inoculum buildup possible on the alternate hosts; spores that infect both hosts are windborne; spore germination and infection are favored by moist conditions in summer.

Management: Remove alternate hosts within 500′ of spruce seed orchards if the disease has been a problem in the past.

May be Confused With: Insect damage.

Spruce cones infected by *Chrysomyxa pirolata*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Stalactiform Rust

Stalactiform rust is caused by the fungus *Peridermium stalactiforme*. This disease is quite common in Pacific Northwest lodgepole pine stands, however, the percentage of trees infected is usually quite low. Infection causes stem malformation, and breakage, but seldom tree killing. Lumber recovery from infected trees is poor because the wood is pitch-soaked at canker sites.

Hosts: Primary host - lodgepole pine; alternate hosts - Indian paintbrush and other members of the Scrophulariaceae.

Recognition: Young infections appear as slight spindle-shaped swellings on stems and branches. Older infections produce diamond-shaped cankers that can be up to 30 feet long. Cankers are pitch-soaked and yellow. Bark on canker faces sloughs off, leaving ridges; rodents frequently gnaw bark around infections. Small inconspicuous blister-like swellings with clear ooze appears on young cankers. Yellow spore pustules (aecia) form on the edge of active cankers in early summer. Orange spore pustules (uredia and telia) are produced on leaves of alternate hosts in the summer.

Disease Spread: Aeciospores produced in May through August are windborne and infect the alternate host; pines are infected during late summer and fall by windborne spores; infection of both hosts is favored by moist conditions.

Management: Remove infected trees during thinning and stand improvement projects; removal of alternate host is impractical.

May be Confused With: Atropellis canker, western gall rust, wounds.

Aecial stage of
stalactiform rust on pine

Stalactiform rust canker on
lodgepole pine

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Swiss Needle Cast

Swiss needle cast is caused by the fungus *Phaeocryptopus gaumanni.* This disease is very common in western Oregon and Washington. Damage is seldom serious in forest stands, but is probably the most important disease in Christmas tree plantations.

Hosts: Douglas-fir.

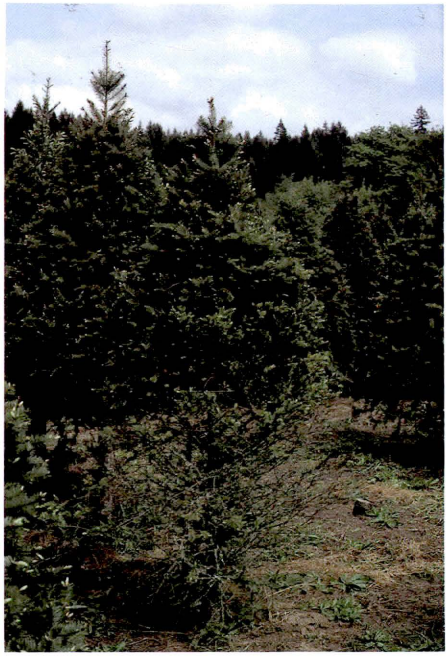
Recognition: Yellowing and browning of infected previous year's needles in spring shortly after current needles emerge; loss of 1- and 2-year-old needles in summer; needle casting begins in the lower portion of tree crowns and progresses upward. Severely infected trees may have only current season's needles in the fall. Tiny black fruit bodies (perithecia) of the fungus appear in the stomatal openings on the underside of current year's needles as early as October and increase in numbers throughout the winter and spring; large numbers of fruit bodies cause the normally white stomatal rows to appear black.

Disease Spread: Perithecia mature in April and May on 1-year-old needles; spores released from them are windborne; spore release is dependent upon wetting of the fruit bodies; spore germination also requires ample moisture on current season's foliage. The disease is most noticeable following wet springs. Succulent foliage, dense stocking and moist conditions favor infection. There is considerable variation in susceptibility to infection between seed sources.

Management: Usually none is warranted in forest stands; disease normally causes growth loss, not mortality; may be controlled in Christmas tree plantations by one application of chlorothalonil, maneb, or benomyl applied in early June.

May be Confused With: Rhabdocline needle cast, root diseases.

Perithecia of *Phaeocryptopus gaumanni* on undersurface of Douglas-fir needles



Defoliation caused by Swiss needle cast

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

True Fir Dwarf Mistletoe

True fir dwarf mistletoe, *Arceuthobium abietinum*, infests thousands of acres of true fir types in southern Oregon and the eastern slopes of the Cascades in Oregon. Infestations are not common in Washington. Infection results in growth loss, wood quality reduction, and tree killing, especially in old trees.

Hosts: Primary- white, grand, and Shasta red fir; Secondary- Pacific silver fir. There are two varieties of true fir mistletoe; one on white and grand fir and one on red fir. White fir dwarf mistletoe does not infect red fir and vice versa.

Recognition: Leafless yellow-green dwarf mistletoe shoots (about 3 to 8 inches long) appear on infected branches; basal cups of detached shoots remain on branches. Infection causes branch and stem swellings, witches'-brooms are small and flat; branch flagging is accentuated by fungi that invade mistletoe infections. Severely infected trees are predisposed to attack by fir engravers (*Scolytus ventralis*) and possibly root diseases.

Disease Spread: Seeds are sticky and forcibly discharged up to 50 feet from the fruit in the fall, landing on surrounding trees. Infection takes place on branches or stems where bark is thin in the spring; spread is most rapid in multi-storied stands; spread in single-storied stands averages 1-2 feet per year; death of the host results in death of dwarf mistletoe.

Management: Clearcut severely infested stands; remove infested overstory from manageable susceptible understory; remove infected trees when thinning lightly infested stands; destroy infected live residuals left after clearcutting, fires, or blowdown; favor non-hosts in mixed stands. Trees with open-faced stem cankers should be treated in recreation areas. Trees with good live-crown ratios can tolerate heavier infection levels than trees with poor live-crown ratios.

May be Confused With: Fir broom rust. Hemlock dwarf mistletoe, but the effects on hosts are the same.

Arceuthobium abietinum on white fir

Mistletoe stem canker

Flagging in grand fir caused by true fir dwarf mistletoe and canker fungi

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

True Mistletoes

True mistletoes in the Pacific Northwest are all members of the genus *Phoradendron.* The most conspicuous true mistletoes infect oaks in western and southern Oregon. Severe infestations can cause growth loss, branch dieback, and tree killing.

Hosts: Hardwoods (oaks), junipers, incense cedar.

Recognition: Infection can cause excessive twig formation (witches'-brooms); occasionally branch death.
Conspicuous leafy, perennial evergreen tufts of mistletoe shoots; stems and leaves are green but may have a yellow or brown cast; seeds are pearly white.

Disease Spread: Seeds are borne in white or red fruits and are distributed by birds and other animals; unlike dwarf mistletoes, the seeds are not forcibly discharged; infection occurs on young, thin bark of host; plants make most of their own food by photosynthesis but obtain water and some nutrition from their hosts; generally causes little damage except in cases where mistletoe plants are extremely numerous.

Management: Usually not warranted; remove heavily infected individuals. Prune severely infected branches. Harvest plants for Christmas smootching.

May be Confused With: Dwarf mistletoes, incense cedar rust.

True mistletoe on oak

True mistletoe on juniper

True mistletoe on incense cedar

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Western Dwarf Mistletoe

Western dwarf mistletoe, also called ponderosa pine dwarf mistletoe, *Arceuthobium campylopodum*, infests 26% of the ponderosa-Jeffrey pine type in the Pacific Northwest. Infected trees experience growth loss, wood quality reduction, and premature death.

Hosts: Principal- ponderosa, Jeffrey, and knobcone pine; Secondary- lodgepole pine.

Recognition: Leafless, olive-green to yellow dwarf mistletoe shoots (3-8 in. long) on infected branches; basal cups remain after shoots die. Branch and stem swellings, witches'-brooms, branch flagging, dead tops, deformed trees.

Disease Spread: Seeds are sticky and forcibly shot from fruits in the fall (max. distance 100 ft.); seeds germinate in spring, infection occurs on thin bark wood; infections cause branch or stem swellings and eventual death of member; death of host results in death of parasite. Disease spread in dense stands is slow, is fastest at 9-foot tree spacings, and is reduced at 18-foot spacings.

Disease spread is most rapid in multi-storied stands; spread in single-storied stands averages 1-2 feet per year.

Management: Clearcut severely infested stands. Remove infested overstory to protect susceptible understory. Remove severely infected trees in lightly infested stands; favor nonhosts in mixed stands. Prune witches'-brooms to prolong tree life in recreation sites.

May be Confused With: Elytroderma needle blight.

Female dwarf mistletoe plants with seeds on ponderosa pine

Witches'-brooms caused by dwarf mistletoe

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Western Gall Rust

Western gall rust is caused by the fungus *Endocronartium (Peridermium) harknessii*. This is probably the most commonly observed disease of lodgepole pine. Practically all Pacific Northwest lodgepole pine stands are infected. Severe infection causes stem malformation, breakage, and tree killing, especially of seedlings.

Hosts: Two and three-needle pines, especially lodgepole and ponderosa pine.

Recognition: Small to large globose to pear-shaped galls on branches or stems; galls on main stems may continue to grow for years, forming very large, hard burls or may partially girdle the stems and die, developing into cankers. An inconspicuous white or colorless ooze (pycnia) may appear between bark fissures in spring; yellow-orange spore pustules (aecia) are produced in cracks on galls in spring and early summer.

Disease Spread: Aecia are produced each spring as long as the fungus is alive in the host (may be as long as 100 years); spores are windborne and infect other hard pines, no alternate host is required; moist conditions stimulate spore release and favor infection; symptoms may develop the same year as infection or 1 to 2 years later. Infection occurs on succulent stem tissue. The fastest growing trees are more susceptible than suppressed trees.

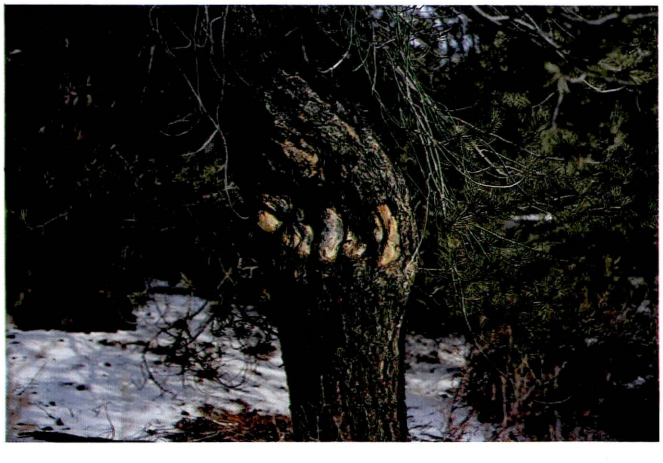
Management: Selective removal of trees exhibiting numerous galls, especially stem galls (trees with only small numbers of branch galls do not suffer much growth loss and may be retained); favor uninfected or lightly infected trees during thinning or seed collection. Trees with deeply indented (¼ to ½ of the bole) cankers on the upper stem should be treated in recreation areas. Branch galls could be pruned from ornamental pines.

May be Confused With: Stalactiform rust, dwarf mistletoe, atropellis canker.

Endocronartium harknessii gall

Aecia on gall in spring

Old gall on main stem



Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

White Mottled Rot

White mottled rot is caused by *Ganoderma applanatum*, commonly called the artist's conk. This fungus is common throughout western Oregon and Washington.

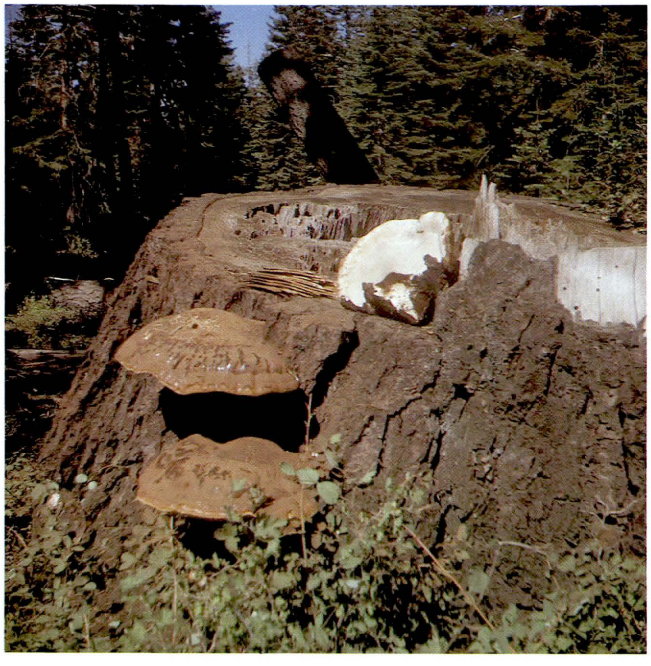
Hosts: Hardwoods, some conifers (especially western hemlock and Douglas-fir).

Recognition: Hard, woody, shelf-like perennial conks which may reach a width of 2 feet or more; upper surface is smooth, zoned, gray to black in color; lower surface is white to yellowish turning brown when bruised, artist's scribe the lower surface. White mottled rot with fine black zone lines.

Disease Spread: Spores are windborne, infection occurs through wounds; mostly found on living or dead hardwoods or dead conifers; does occasionally cause rot of heartwood and living sapwood of conifers.

Management: Avoid tree wounding; remove live trees with broken tops, sizable wounds, or conks; harvest old, decadent trees. Trees with conks should be treated in recreation areas.

May be Confused With: Brown crumbly rot (*F. pinicola*).



Conks of *G. applanatum*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

White Pine Blister Rust

White pine blister rust is caused by the fungus *Cronartium ribicola*. This is the most serious pest of 5-needle pines in the Pacific Northwest. Annual losses are estimated to be about 5 million cubic feet.

Hosts: Primary hosts- western white, sugar, and white bark pines. Alternate hosts- members of the genus *Ribes*.

Recognition: Yellow and red needle spots; spindle-shaped swellings often with small cup-like depressions on branches; cankers with dead roughened bark, margins greenish-yellow to orange; flagging of branches and tops; tree mortality; defoliation of *Ribes*.

Clear, sappy ooze (pycnia) and white to yellow-orange spore pustules (aecia) appear on swollen portions of pine stems in spring; reddish spore pustules and brown tails (uredia and telia, respectively) develop on the underside of *Ribes* leaves in spring and summer.

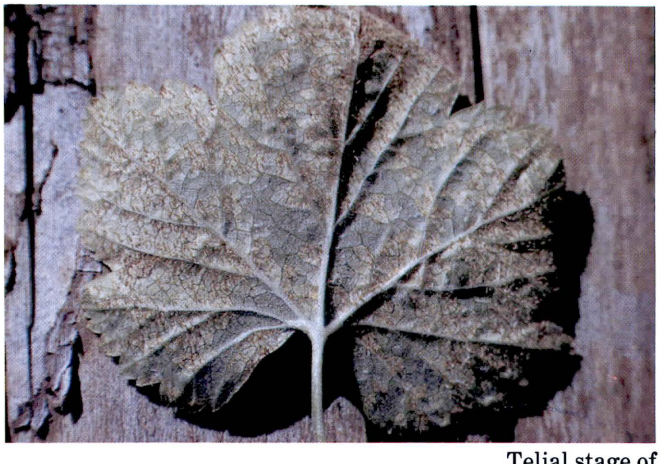
Disease Spread: 5 spore stages in life cycle; both pine and *Ribes* hosts are essential for completion of life cycle; spores that initiate infections on both pines and *Ribes* are windborne; 48 hours with saturated air and with a maximum temperature of not over 68°F are necessary for infection of pines; cool, moist conditions during summer and autumn greatly favor the disease while warm, dry conditions are unfavorable.

Management: Rate sites for infection hazard; reforest with resistant 5-needle planting stock on medium and high infection hazard sites; retain uninfected or very lightly infected trees for seed sources when cutting severely infected stands; branches with cankers more than 4 inches and less than 24 inches from the stem can be pruned; attempts to eliminate the alternative host (Ribes) or develop chemical controls have proven unsuccessful.

May be Confused With: Mountain pine beetle damage.

Branch infection that has spread to the stem

Aecial stage of *Cronartium ribicola*



Telial stage of *Cronartium ribicola* on *Ribes*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

White Pocket Root and Butt Rot

White pocket root and butt rot is caused by the fungus *Inonotus (Polyporus) tomentosus*. This disease is seen most frequently in Engelmann spruce, but it is not widespread in the Pacific Northwest. It can cause serious damage within infected stands.

Hosts: Spruces, true firs, lodgepole and ponderosa pine.

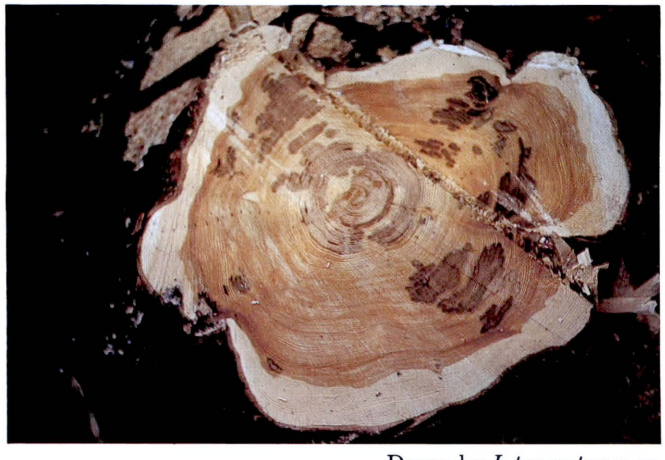
Recognition: Crown symptoms (stunting, yellowing) appear in severely infected trees; presence of disease indicated primarily by uprooted trees and stand openings; decay of root and stem appears as small, square pockets separated by firm wood (honeycombed).

Small (1 - 2.5-inch diameter) yellow to rusty brown mushrooms with a central stalk appear on the ground or on the tree in the fall; upper surface is velvety to hairy; undersurface is white.

Disease Spread: The fungus spreads from tree to tree by root contacts; fungus growth is slow, hence above ground symptoms may be delayed several years after infection; windborne spores may function in the spread of the disease.

Management: Harvest visibly infected and nearby "high risk" trees in severely infected areas. Trees with basal conks should be treated in recreational areas. Not commonly found in Oregon and Washington.

May be Confused With: Brown cubical butt rot, other root diseases.



Decay by *I. tomentosus* on ponderosa pine

Fruiting body of *I. tomentosus*

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

White Trunk Rot Of Aspen

White trunk rot is caused by the fungus *Fomes ignarius* var *populinus*, also commonly called the false-tinder fungus. This is the most common cause of stem decay in aspen.

Hosts: Aspen, alder, other hardwoods.

Recognition: Soft yellow-white decay with zone lines in the heartwood.

Conks are hard, variable in shape, ranging from shelf-like to hoof-like; upper surface gray to black and divided into irregular squares by numerous cracks; under-surface medium brown and pitted by numerous tiny pores.

Disease Spread: Spores are released from conks during periods of high relative humidity and warm temperature; spores enter branch stubs, cankers, or wounds, and the underlying wood is colonized and eventually decayed.

Management: Avoid trunk wounds, the principal infection courts of the fungus. Maintain uniform well-stocked stands and harvest at ages 80 to 100 years or earlier to reduce decay losses. Trees with conks are defective and should be treated in recreation areas. Aspen with conks have an average cull of 82% of the gross tree volume.

May be Confused With: Nothing if conks are present.

Conks of *F. ignarius* on aspen

Decay caused by *F. ignarius* on aspen

Forest Disease Management Notes

United States
Department of
Agriculture

Forest Service
Pacific Northwest
Region

Yellow Brown Top Rot

Yellow brown top rot is caused by *Fomitopsis cajanderi*, formerly called *Fomes subroseus*. This fungus causes decay in broken-top trees.

Hosts: Most damaging on Douglas-fir (especially on the West Side); occasionally affects other conifers.

Recognition: Infection causes a green stain that develops into a brown pocket rot of the heartwood below the break. Trees with broken tops, volunteer tops, crooks, or forked tops, especially if frequent in the stand, indicate a high probability of infection. Small, inconspicuous, perennial conks occur in crotches of malformed tops or in breaks; tops of conks are dark gray or black; undersurfaces pink or rose-colored.

Disease Spread: Windborne spores infect primarily broken tops; amount of decay increases with break diameter and time since break.

Management: Remove broken-top trees when thinning. Stand replacement should be considered if damage is sufficiently severe to leave few or no crop trees. Stands near commercial size may be carried through the rotation if sufficient crowns remain.

May be Confused With: Brown trunk rot *(F. laricis)*; brown crumbly rot *(F. pinicola)*.

Fomitopsis cajanderi conks

Decay caused by
Fomitopsis cajanderi